NIMBLE: Many-time, Many-where communication support for information systems in highly mobile and wireless environments
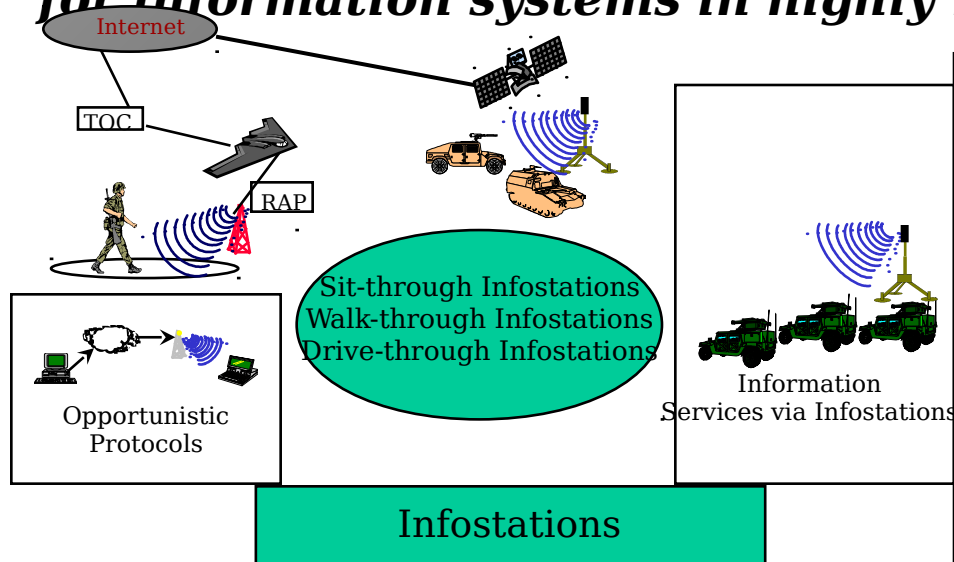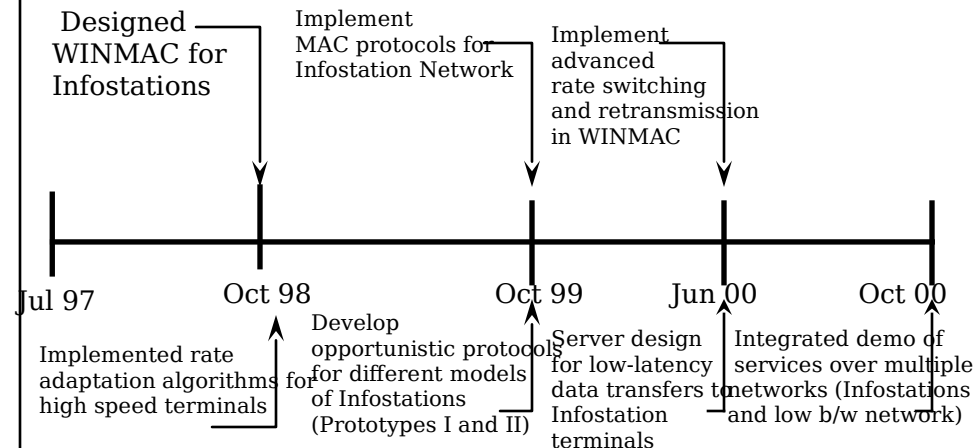
Internet

TOC

RAP

Sit-through Infostations
Walk-through Infostations
Drive-through Infostations

Opportunistic Protocols

Information Services via Infostations

Infostations

New Ideas:

- Infostations
  - Many-time, many-where communication paradigm
  - Spotty wide-band coverage for fast data transfer
  - Different types of Infostations
- Low Latency Protocols
  - Reservation protocols for Infostations
  - Adaptive content, rates for low latency transfers
  - Caching, scheduling, transfer protocols
- Applications
  - Drive-by services
  - Spooled high speed data transfers
  - Integrating low b/w network and infostations

Impact:

- A new architecture for providing wide-band coverage at specific places
- Opportunistic protocols for delivering rich data at peak rate to moving terminals
- Novel service models for delivering high data rate services tailored to different mobility patterns
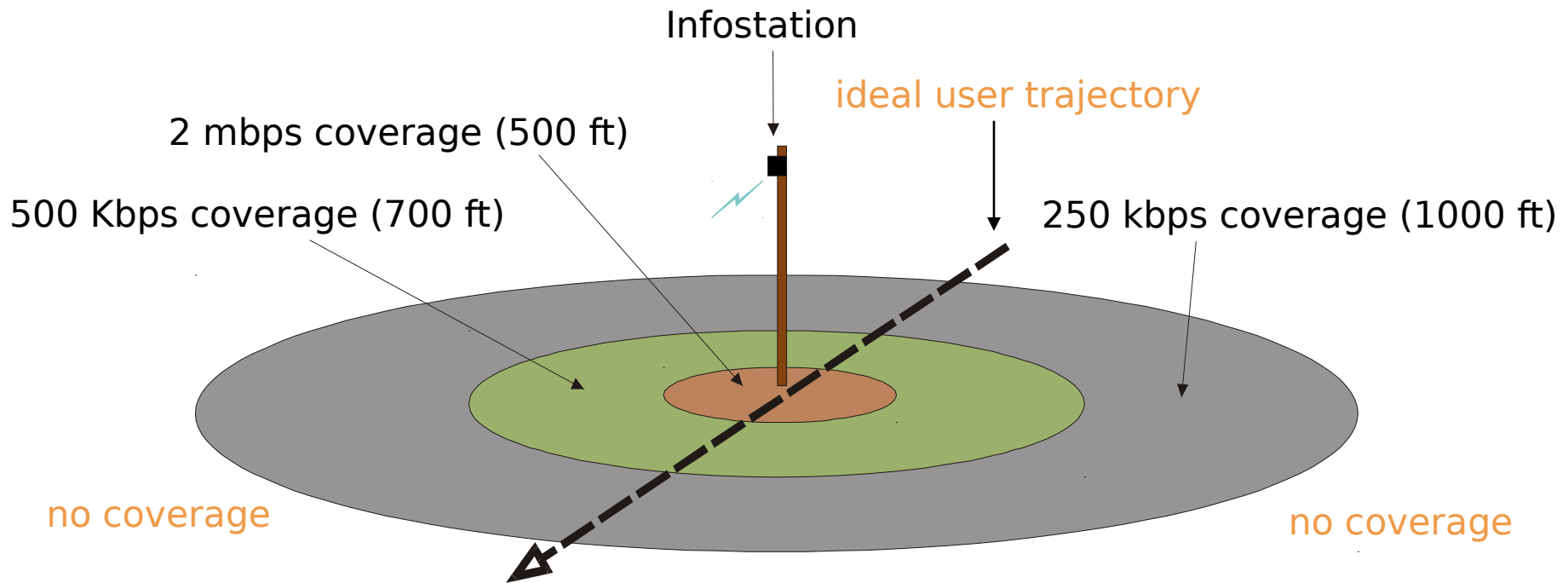
Schedule:

Designed WINMAC for Infostations

Implement MAC protocols for Infostation Network

Implement advanced rate switching and retransmission in WINMAC

Jul 97   Oct 98   Oct 99   Jun 00   Oct 00

Implemented rate adaptation algorithms for high speed terminals

Develop opportunistic protocols for different models of Infostations (Prototypes I and II)

Server design for low-latency data transfers to Infostation terminals

Integrated demo of services over multiple networks (Infostations and low b/w network)

Rutgers University - B. R. Badrinath, Richard Frenkiel, David Goodman, Tomasz Imielinski

NIMBLE significant recent accomplishments

- Infostations MAC: *Rate adaptation at the MAC layer* *Q499*
  - **Rate adaptation in the MAC for high velocity mobile terminals (**tested 30 mph, goal 60 mph**)**
    - Mobile dynamically selects best available data rate using real-time channel measurements.
    - **Low rate: 250 kbps, Medium rate: 500 kbps, High rate 2 Mbps**
  - **Significant throughput improvement in a fading (mobile) environment.**
  - **Allows for fringe area low bandwidth communication to overcome backbone latencies.**
- Infostations MAC: Adaptive link layer retransmission.   *Q3 99*
  - **Adaptive redundant retransmission based on error in the channel**
  - **Threshold based retransmission: dynamically decides number of retransmissions**
- Optimal file caching algorithm for an Infostation network. *Q2 99*
- Radio-API Simulator *Q1 99*
  - **Testing of WINMAC blocks in a simulated environment**
  - **Evaluated WINMAC components**

Infostation Coverage Pattern

Infostation

ideal user trajectory

2 mbps coverage (500 ft)

500 Kbps coverage (700 ft)

250 kbps coverage (1000 ft)

no coverage

no coverage

Infostation coverage pattern:

High data rate service is available only near the infostation.
Majority of data transfer occurs at the center of the cell.

Low data rate ring is used to register and initiate a data transfer.
Need fast rate switching and adaptive retransmission schemes

Rate Switching

- Mobile dynamically adjusts the rate
  - **This is decided based on channel quality**
  - **Channel quality is determined based on the number of beacons received and their type**
- If sufficient high rate beacons are received then the mobile switches to a higher rate
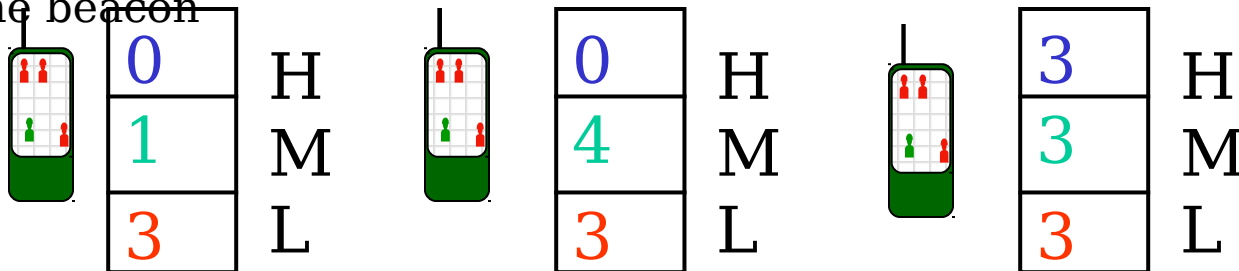- Three rates implemented: 250 Kbps, 500 Kbps and 2 Mbps

Rate Switching Algorithm

Beacons are sent at three different data rates.

Based on the channel conditions
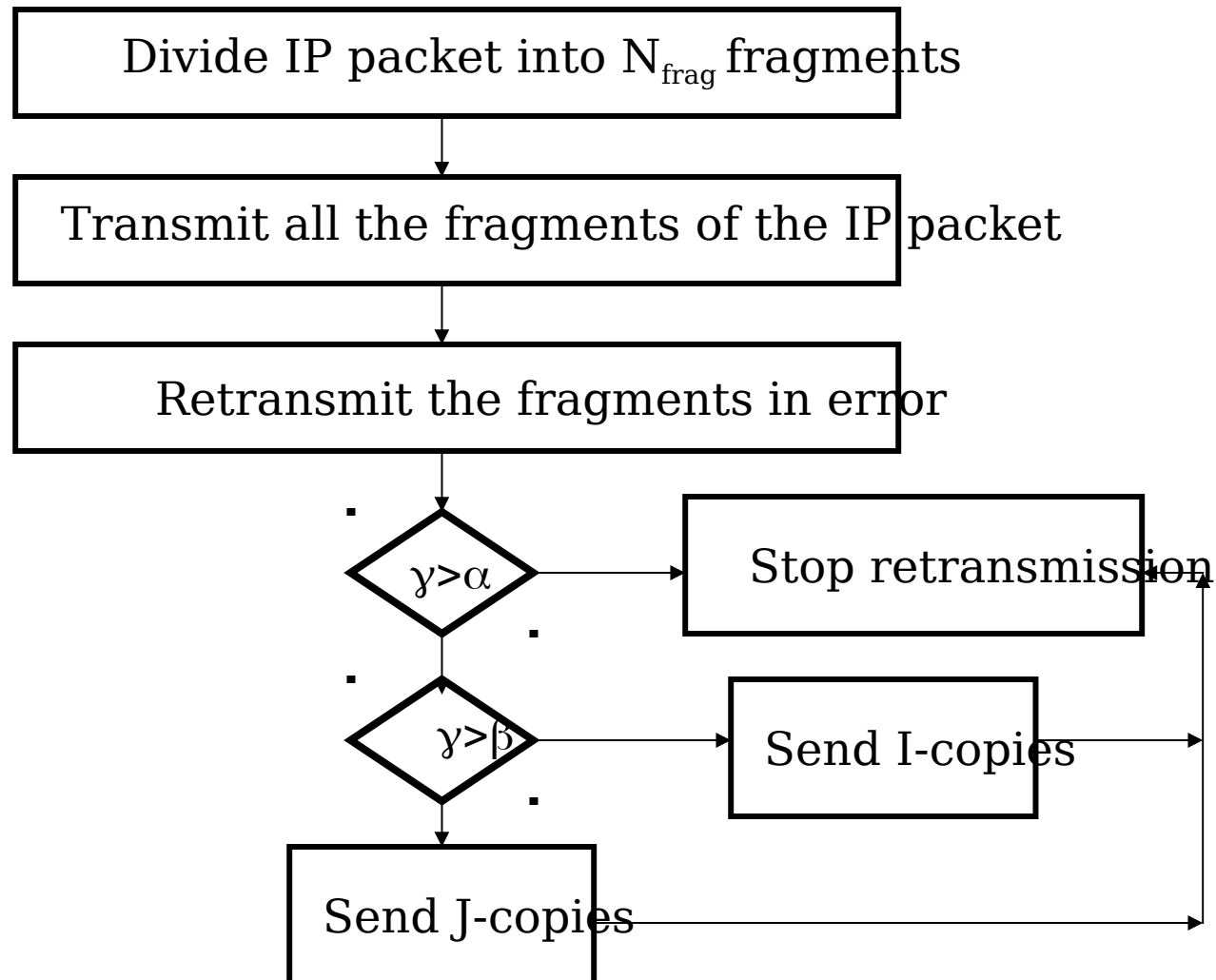the mobile receives one or more of
these beacons.
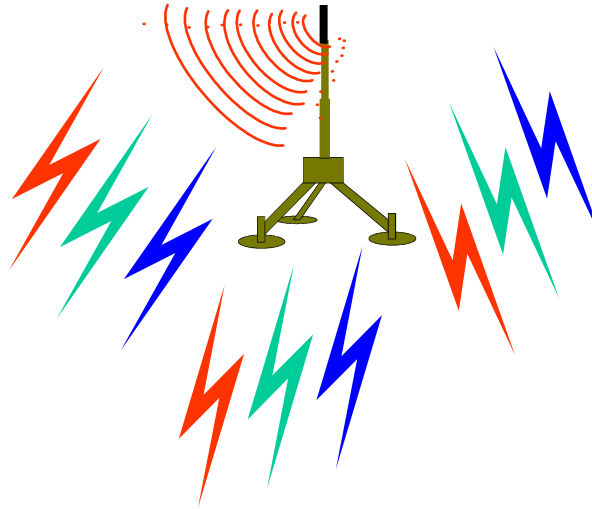
Based on what is received the mobile makes a decision to stay at the given rate or switch to higher ~~(lower)~~ rate based on the beacon counters.
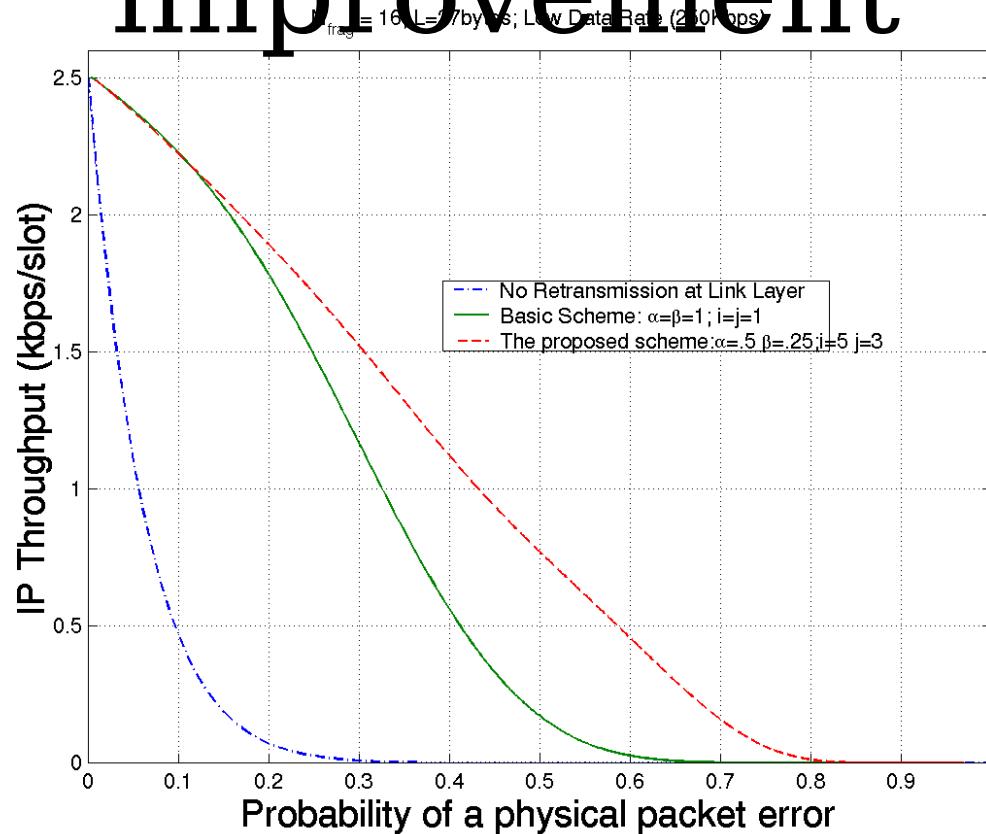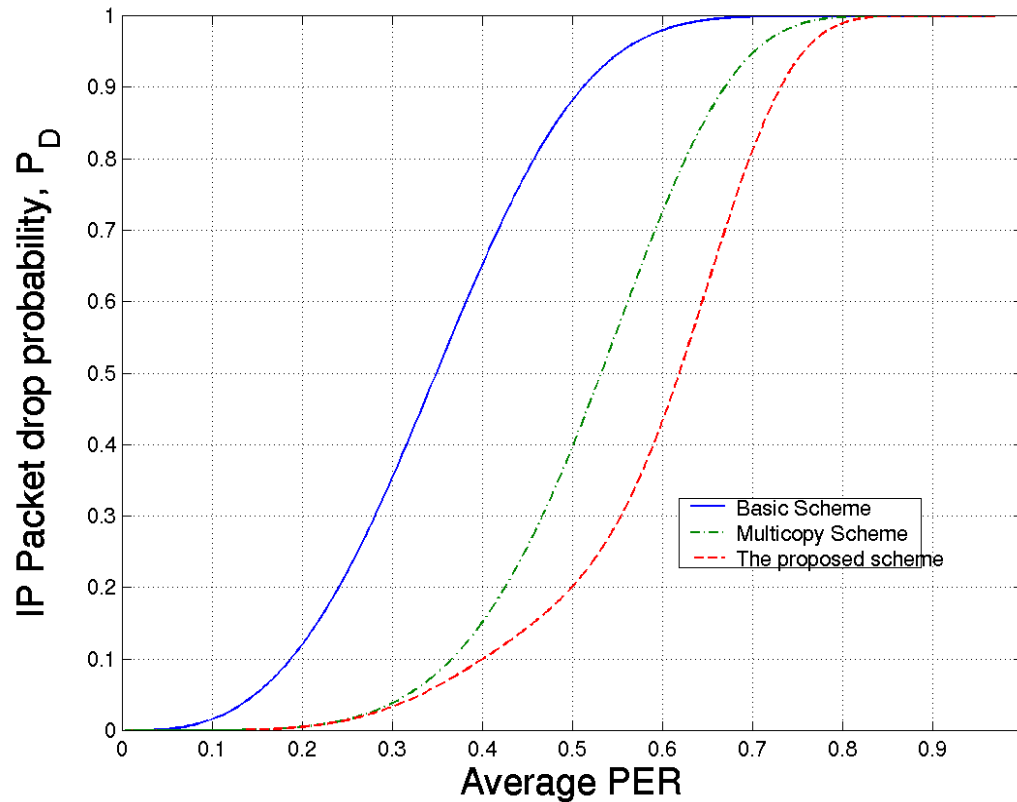
0	H
1	M
3	L

0	H
4	M
3	L

3	H
3	M
3	L

H = 2 Mbps, M = 500 Kbps, L=250 Kbps

Adaptive Retransmission

Divide IP packet into N_{frag} fragments

Transmit all the fragments of the IP packet

Retransmit the fragments in error

$\gamma > \alpha$

Stop retransmission

$\gamma > \beta$

Send I-copies

Send J-copies

IP throughput improvement

$N_{frag} = 16$; $L=7$bytes; Low Data Rate (250Kbps)

Legend:
- No Retransmission at Link Layer
- Basic Scheme: $\alpha=\beta=1$; $i=j=1$
- The proposed scheme:$\alpha=.5$ $\beta=.25$;$i=5$ $j=3$

Y-axis: IP Throughput (kbps/slot)

X-axis: Probability of a physical packet error

IP packet drop probability

Reduction in retransmitted fragments
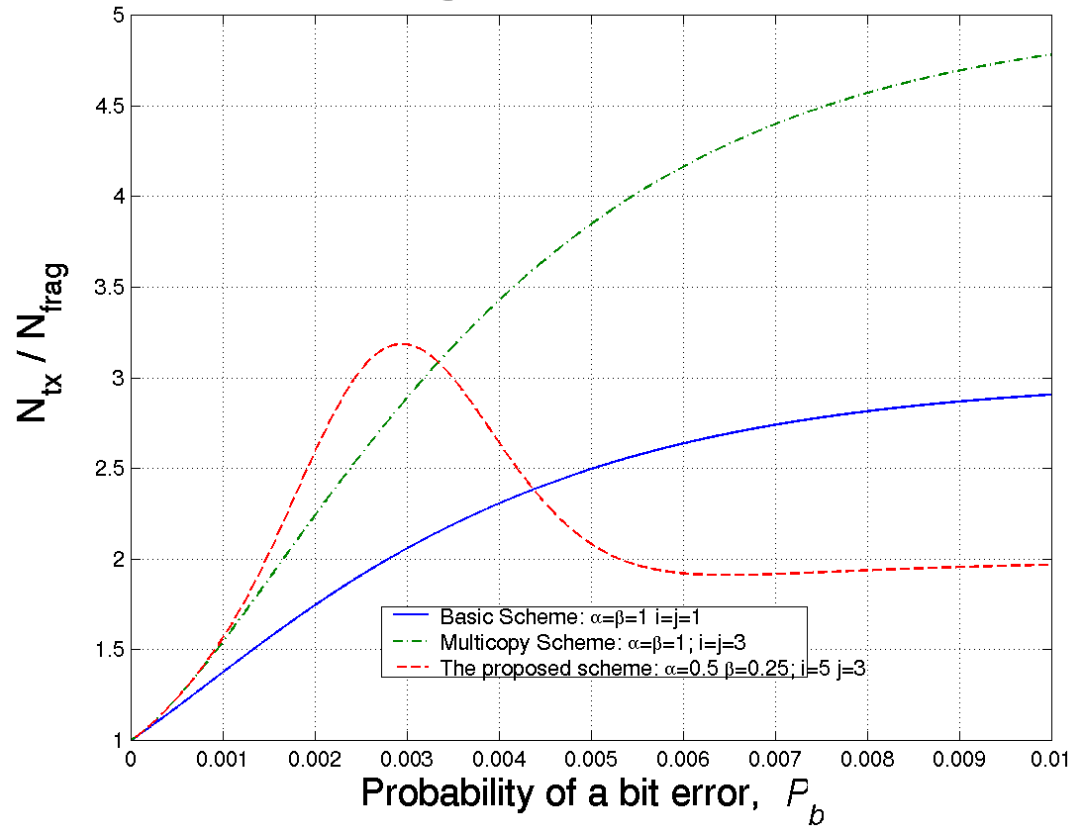
Adaptive redundant retransmission improves IP goodp

Prototype Services

Download /upload huge files from multiple infostations
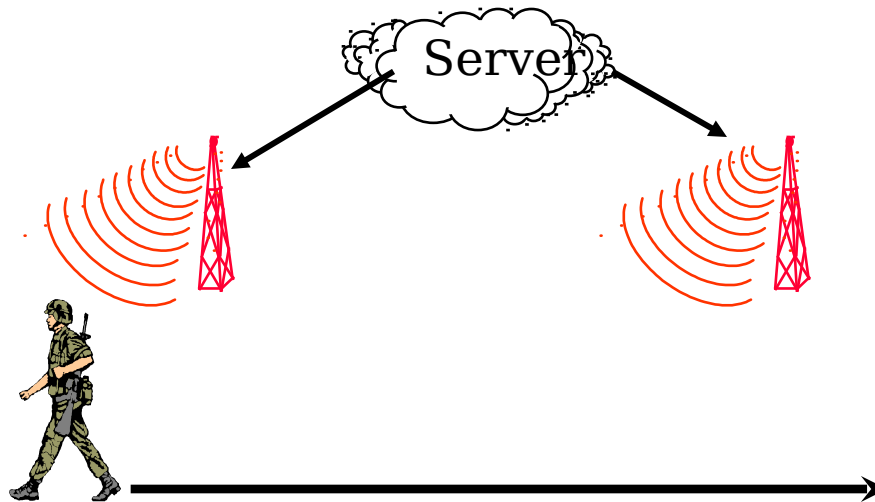
Completing atomic transfers for MIME content (e-mail with attachments,
CD quality audio (teaming with Daimler-Chrysler))

NIMBLE FY00 Plans

- Development of WINMAC For Infostations: 1Q/2Q00
  - **Test and verify advanced rate switching scheme   1Q00**
  - **Complete implementation of adaptive retransmission scheme 2Q00**
- Service architecture for Infostation prototypes   2Q00
  - **Complete Infostation server design and deploy   2Q00**
  - **Complete Infostation client design for various applications 2Q00**
- Build and demo Infostation prototype II   3Q/4Q00
- Integrated demo plans (Final GloMo Demonstration)
  - **Build and demo services using Infostations prototype II**
  - **Show reconciliation of a distributed database via Infostations . Show atomic transfer of data via an Infostations network   4Q00**
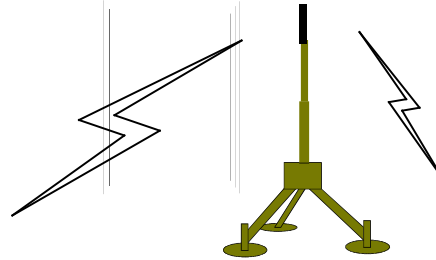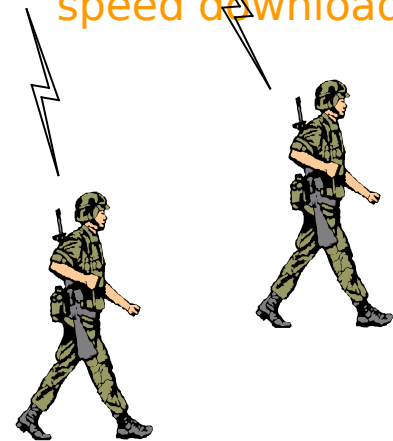
Possible plan for final demo

Infostation

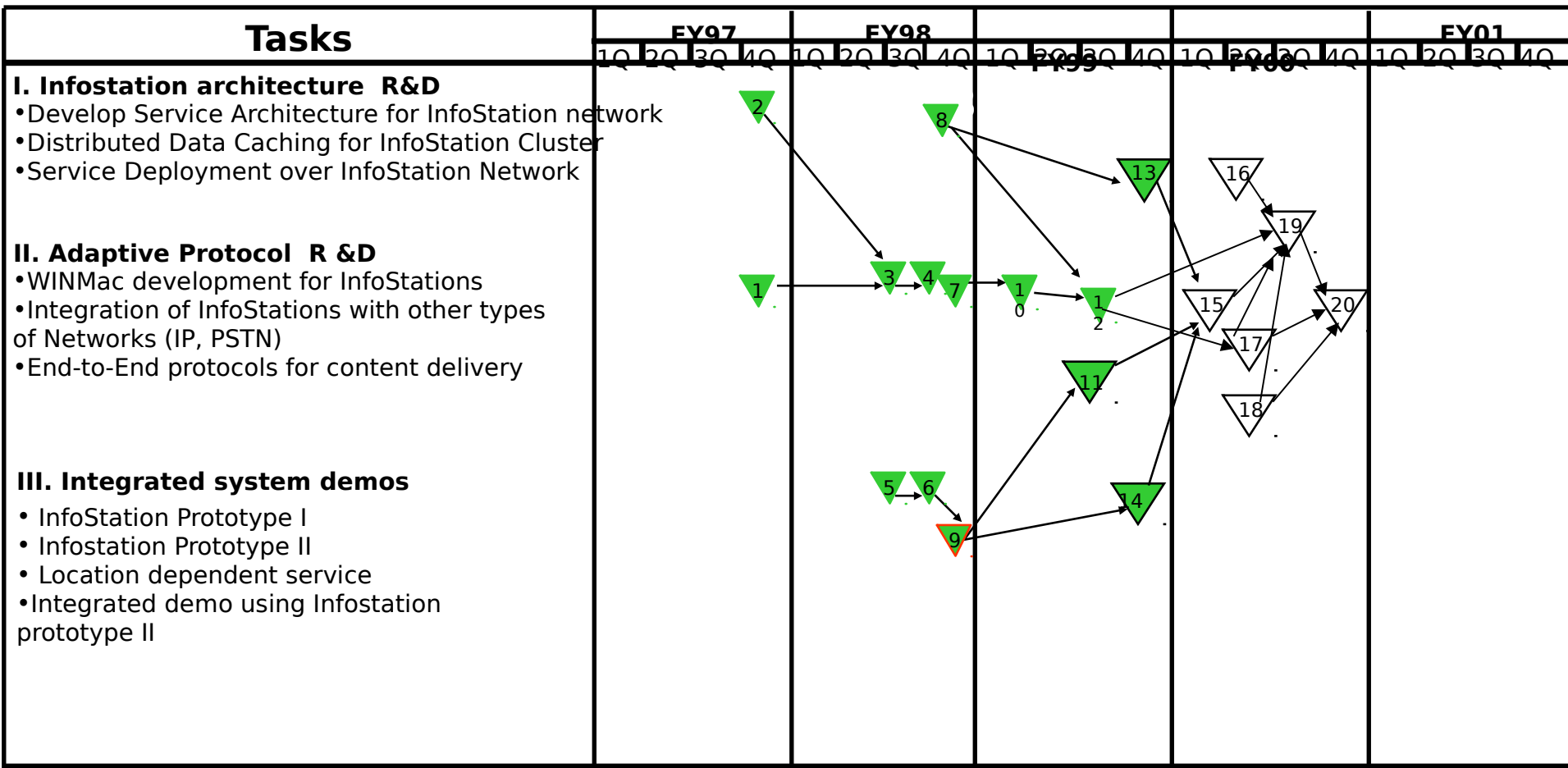1. Warfighters gather troop position data on handheld terminal
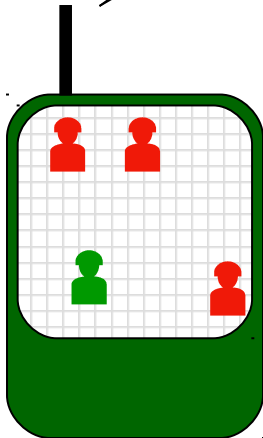
2. Upon approaching infostation, new data is automatically uploaded at high speed and data base is reconciled

3. Mobile users traveling in vicinity of infostation automatically receive updated copy of database in a high speed download

Rutgers NIMBLE - Schedule

Rutgers NIMBLE - Milestones

FY99

7. Complete radio network drivers   Rutgers   4Q98   Completed
8. Demonstrate "Post-It" Service via InfoStation   Rutgers   4Q98   Completed
9. Design rate adaptation schemes for mobile nodes   Rutgers   3Q99   Completed
10. Implement WINMac emulator for optimization Rutgers   1Q99   Completed
11. Complete Implementation of reservation
    scheme for mobile networks   Rutgers   2Q99   On Schedule
12. Demonstrate InfoStation Prototype I   Rutgers   2Q99   Completed

FY00

13. Design of control and data channel for
    InfoStation Prototype II   Rutgers   4Q99   Completed
14. Simulate performance of real-time services
    for mobile networks   Rutgers   4Q99   Completed
15. Advanced rate switching   Rutgers   1Q00   On Schedule
16. Retransmission schemes   Rutgers   2Q00   On Schedule
17. Infostation Server design and deployment   Rutgers   2Q00   On Schedule
18. Infostation client design and deployment   Rutgers   2Q00   On Schedule
19. Demonstrate information services with
    prototypes I and II   Rutgers   3Q00   On Schedule
 20. Integrated demo using InfoStation Prototype II   Rutgers   4Q00   On Schedule